High School Materials
Science: It really works!

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Materials Science & Technology (MST)

- History of MST Curriculum Development
- Overview of MST Modules
- MST Teacher Training
- Impact of MST on Students
- Future of MST
MST Curriculum Development

- Un. of Washington, Materials and Technology Curriculum Project (1973)
- Ball State University, CITE – Center for Implementing Technology Education, Soc. of Manufacturing Engineers (1986-1991)
- Northwestern University, Materials World Modules – NSF (1993)
MST Curriculum Development

- Un. of Illinois at Urbana-Champaign, Materials Science and Technology (MAST) modules – NSF (1993)
- Energy Concepts Inc, MST curriculum modules and lab equipment (1997)
- Un. of Wisconsin-Madison, Institute for Chemical Education (ICE) - NSF
MST Curriculum Development

- Un. of Wisconsin-Madison, Materials Research Science and Engineering Center (MRSEC) – NSF
- ASM Educational Foundation, Materials Camps for students and teachers (2000 – )
What is MST?

- The science of “stuff”
- Multidisciplinary approach
- Chemistry, physics, engineering
- Designed for “team approach”
  - Science and technology teacher
- Hands-on, minds-on
Prevailing Concepts

- Use journal
- Apply concepts throughout all units
- Look at “stuff” from micro to macro
- Learn why and how “stuff” does what it does...by understanding the properties of the “stuff”
How is it Offered?

- Dedicated “stand-alone” class
- Incorporate into traditional science or technology class
- Modules
MST Modules

- Introduction: general properties of materials
- Metals
- Ceramics and glass
- Polymers
- Composites
Solids

- Importance of materials science and technology.
- Solids are typically separated into four categories.
- Simple chemistry including chemical bonding, the periodic table, and oxidation-reduction.
- Crystal structures, physical properties.
- How metals are claimed from their ores.
- Importance of maintaining a student journal and keeping good records is stressed.
Solids Activities

- Material safety data sheets
- Identification of materials
- Formation of crystals
- Destructive testing
- Reactivity series of metals
- Oxidation/reduction of copper
Metals

- Introduce the properties and historical developments of metals.
- Investigate mechanical properties of metals along with the effects of heat-treating.
- Study alloys and alloying techniques along with phase diagrams.
- Study testing of metals and manufacturing processes.
- A major project is the making of sterling silver jewelry using the process of lost wax casting.
Metals Activities

- Rolling a coin
- Drawing a wire
- Alloying copper and zinc
- Cost of a penny
- Making a light bulb
- Making lead-tin solder
- Annealing copper
- Powder metallurgy
- Lost wax casting
Sterling Silver Rings
Ceramics & Glass

- Learn that most ceramics are crystalline solids.
- Study properties related to the ionic or covalent bonds that hold them together.
- Learn that glass has different properties than most ceramics due to the amorphous structure of glass.
- Study processes used to manufacture ceramics including a stained glass and a Raku pottery project.
Ceramics & Glass Activities

- Forming, firing, and glazing clay
- Thermal shock
- Glass bending and blowing
- Glass batching and melting
- Dragon dribble & dragon tears
- Coloring glass
- Stained glass project
- Making Raku
- Ceramic slip casting
Colored Glass
Fused Glass
Raku Test Samples
Polymers

- Study synthetic polymers and their chemistry.
- Include the classification of polymers along with how they are altered chemically or with additives.
- Emphasize concerns with recycling.
- Review the chemical changes brought about by cross-linking.
- Include historical developments and manufacturing processes.
Polymer Activities

- Cross-linking a polymer (slime)
- Polymer identification
- Making nylon 6-10
- Latex rubber ball

- Memory in polymers
- Epoxy resin cast
- Polymer foam creations
Resin Cast Clothespin
Composites

- Describe and categorize types of composites.
- Emphasize strength-to-weight ratios including strength measuring, testing, and altering.
- Use wood and concrete as two traditional composites to introduce many concepts.
- Discuss fiber reinforced composites including those containing graphite and Kevlar fibers.
Composite Activities

- Stressed-skin composites
- Plaster of Paris matrix composite
- Compression and tension in a bending beam
- Laminated wood beams
- Using Portland cement to make & test concrete
- Hand lay-up of a glass fiber reinforced polymer
Coremat® & Graphite Cloth
Clipboard
MST is FUN!!!
# MST Teacher Training

(Over 1000 trained!)

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MST Training Resources

- 600 copies of PNNL MST Teachers Handbook distributed throughout U. S.
- 45 MST labs installed by Energy Concepts Inc.
- 500 schools are using Materials World Modules
States that have MST Classes

- California
- Colorado
- Florida
- Illinois
- Iowa
- Kansas
- Massachusetts
- Michigan
- Mississippi
- Missouri
- Ohio
- Oregon
- Pennsylvania
- Tennessee
- Virginia
- Washington
- Wisconsin
Student Comments

- "I love working with materials. I learn so much easier by working with my hands."
- "It was a non stop action class. Almost everyday we are doing something new. I got to make a lot of cool stuff that I can keep forever."
- "My friends used this class as a stepping stone to get into the Manufacturing Boeing Internship in Auburn."
Student Survey (250 Students)

- When asked if they would recommend this class to other students:
  - 76% said yes
  - 19% said probably
  - 5% said no
When asked to complete the following sentence, "I like materials science because" they finished the sentence with three general themes:

- The most frequently mentioned idea concerned learning about different materials and then using them to make a project.
- The second most common response was the theme of hands-on work.
- The third most common response was that the lab activities were fun!
Other Findings

- Students become more interested in further science study after taking this course.
- Chemistry and physics courses became more popular as a result of the MST course.
- Significant enhancement in the understanding of science and in career opportunities in science and technology.
- Provides a means for motivating teachers to engage students more in real science and to motivate students toward more understanding of science and engineering.
Change in perception of science
- Improved writing skills
- Developed problem solving skills
- Developed hand-on skills
- Saw career opportunities
- Self concept improved

Future of MST

- Teacher training
- Equipment and facilities
- Science/Technology standards
- Test accountability
- School administration approval
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References

- MAST- Materials Science and Technology Teacher's Workshop, prepared by the Materials Science and Engineering Department at the University of Illinois, Urbana/Champaign, Judy Brewer c/o MAST Modules, 1304 W. Green Street, Urbana, IL 61801 (217) 333-1441, http://matse1.mse.uiuc.edu/~tw
- Institute for Chemical Education (ICE), Kathleen M. Shanks, Outreach Program Manager, Department of Chemistry, 1101 University Avenue, Madison, WI 53706-1396, 608-262-2940, 800-991-5534 FAX: 608-265-8094, shanks@chem.wisc.edu, http://ice.chem.wisc.edu
- University of Wisconsin Materials Research Science and Engineering Center on Nanostructured Materials and Interfaces, http://mrsec.wisc.edu/edetc/
References (cont.)

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- CITE - Center for Implementing Technology Education, Ray Shackelford and Jack Wescott Curriculum Specialists, Thomas Wright Project Director, Department of Industry and Technology, Ball State University, Muncie, Indiana 47306
- ASM Foundation Materials Camp
  [http://www.asminternational.org/Content/NavigationMenu/ASMFoundation/Materials_Camp/Materials_Camp.htm](http://www.asminternational.org/Content/NavigationMenu/ASMFoundation/Materials_Camp/Materials_Camp.htm)